



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

LITERATURE CITED.

- ANDERSON, JOHN F. 1909. The Relative Proportion of Bacteria in Top Milk (Cream Layer) and Botton Milk (Skim Milk) and its Bearing on Infant Feeding. *Jour. Inf. Diseases*, Vol. 6, p. 392.
- HEINEMANN, P. G., LUCKHARDT, A. B., and HICKS, A. C. 1910. On the Production of Sanitary Milk. *Jour. Inf. Diseases*, Vol. 7, pp. 47-66.
- HEINEMANN, P. G., and CLASS, E. 1911. The Bacterial Content of Separator Cream and Milk. *Am. Jour. Public Health Assoc.*, Vol. 1, pp. 209-210.
- ROADHOUSE, C. L. 1914. Effect of Distribution of Bacteria in Milk. *Cal. Report of 1914*, p. 184.
- SWINTHINBANK, H., and NEWMAN, G. 1903. *Bacteriology of Milk*, p. 144.
- STOCKING, W. A. 1911. Influence of Separation upon the Germ Content of Milk. *Marshall, Microbiology*, p. 318.
- WILCKENS, ERICH. 1894. Ueber die Verteilung der Bakterien in Milch durch die Wirkung des Centrifugierens. *Centrabl. f. Bakt. Abteilung I*, Ref. vol. 16, p. 969.
- DEPARTMENT OF BACTERIOLOGY, KANSAS AGRICULTURAL EXPERIMENT STATION.

THE MICROBIAL FLORA OF GRADED CREAM.

O. W. HUNTER and L. D. BUSHNELL.

A FEW years ago the state dairy commissioner of Kansas, in coöperation with several departments of the Experiment Station, undertook a systematic study of cream production. It was the aim of the investigation to devise a simple but practical method for grading the quality of cream, hoping thereby greatly to improve the general type of cream as produced throughout the state. The cream was classified into two grades, according to its acid content, that with an acidity of 0.5 percent or less being first grade, and that with an acidity over 0.5 percent being second grade. The department of bacteriology of the station determined the microbial flora of the different grades of cream, with the ultimate purpose of establishing a correlation between the microbial content of cream and its quality.

The quality of cream is inferior when it possesses undesirable flavors and odors. These can be traced to the following sources:

1. Food which the animal has eaten.
2. Absorption of odors after milking.

3. The action of microorganisms after production.

All of these sources are more or less important, but the most important flavors and odors originating in cream result from microbial activity.

The different groups of organisms common to milk can be classed into desirable and undesirable types, depending almost entirely upon their fermentation processes as related to their usefulness in dairy products. Those organisms producing agreeable flavors and odors must necessarily be considered desirable types, while those that produce disagreeable flavors, odors or changes are undesirable. The type of fermentation needed for the manufacture of each dairy product will govern the desirability of microorganisms, and on account of the large number of dairy products, the usefulness of these respective types will vary.

The microbial flora of cream consist of practically the same organisms as found in milk, and may be classified into the following groups, based upon their types of fermentation :

1. The *acid group*, represented by the common milk-souring bacteria, *Bact. lactis acidi*.
2. The *gas-producing group*, consisting primarily of the *colon-xerogenes group*, and yeasts.
3. *Gelatin liquefying group*, which is not represented by any specific organism, but usually consisting of a miscellaneous group of spore- and nonspore-producing organisms.
4. *Neutral group*, consisting of those organisms exerting no marked effect in milk.

Of these four groups only the acid group is desirable from a butter-making standpoint, all others being undesirable. If the flavors and odors common to cream result from the action of microorganisms, it seems logical to assume that a larger percentage of the desirable organisms would exist in first-grade cream than in second-grade. On the other hand, a higher percentage of undesirable organisms would probably be found in second-grade cream.

In the following classification of the types of microorganisms found in the different cream samples the lactic-acid group will always be considered the desirable type, while the yeasts, colon group, gelatin liquefiers and the neutral type will be referred to as the undesirable type.

METHOD OF PROCEDURE.

Under the direction of the state dairy commissioner, samples of cream were collected from different cream stations of the state and sent to the bacteriology laboratory for analysis. The samples were collected in sterile bottles and kept in well-iced containers until the laboratory was reached. The length of time from collection to analysis ranged from twelve to forty-eight hours. All samples analyzed reached the laboratory in good condition. As soon as received, the flavor, odor and acidity of the samples were recorded and the bacteriological examination made.

The bacteriological analysis consisted in making a quantitative estimate of the number of organisms of the different groups present in the cream. No cultural study of the different organisms was made except to demonstrate to the satisfaction of the investigators that the media used for differentiating the various groups were dependable. One cubic centimeter of the cream was diluted in sterile water blanks until the proper dilutions were obtained for inoculating plates. The following media were used for differentiating the various groups of organisms:

Litmus lactose agar for differentiating the acid-producing group from the neutral or alkaline type of organisms.

Plain gelatin for determining the number of liquefiers.

Bile lactose agar for enumerating the colon group.

Laurent's yeast media for identifying the number of yeasts.

The temperature of incubation was 37° C. for two days for all media except the gelatin plates, which were held at 18° C. for ten days.

EXPERIMENTAL DATA.

The data obtained from the few samples of cream examined during the summer this grading system was established failed to show, from a bacteriological standpoint, much in favor of this method of grading. However, the practical results obtained in the field seemed to warrant its use the following year for further study. The complete analyses of 44 samples of cream are summarized in Table 1. This gives the average of the different groups of organisms present in each grade of cream, and not the individual data obtained from each sample of cream. Table 2 shows the percentage of the desirable and undesirable types present in first- and second-grade cream.

The results indicate practically no difference between the microbial flora of the two grades of cream.

TABLE 1.

Summary of the different types of microorganisms observed in 44 samples of cream when graded into first- and second-grade cream by 0.5 percent acid.

TYPE.	Number per cubic centimeter.	
	First-grade cream.	Second-grade cream.
Lactic acid type.....	89,000,000	57,000,000
Neutral type.....	76,000,000	36,000,000
Liquefying type.....	2,200,000	9,000,000
Colon group.....	100,000	250,000
Yeasts.....	600,000	500,000

TABLE 2.

Classification of the groups of microorganisms found in first- and second-grade cream, when 44 cream samples were graded on a 0.5 percent acidity basis.

TYPES.	First-grade cream.		Second-grade cream.	
	Number.	Percentage.	Number.	Percentage.
Desirable.....	89,000,000	52.6	57,000,000	55.4
Undesirable.....	79,900,000	47.3	45,750,000	44.5

In the summer of the following year 135 samples of cream were examined. The data are summarized in tables 3 and 4.

TABLE 3.

Summary of the different types of microorganisms observed in 135 samples of cream when graded into first and second-grade cream by 0.5 percent acidity basis.

TYPE.	First-grade cream.	Second-grade cream.
Lactic acid type.....	216,000,000	283,000,000
Neutral type.....	56,000,000	67,000,000
Liquefying type.....	4,400,000	3,800,000
Colon group.....	500,000	500,000
Yeasts.....	800,000	600,000

TABLE 4.

Classification of the groups of microorganisms found in first- and second-grade cream, when 135 samples were graded on a 0.5 percent acidity basis.

TYPE.	First-grade cream.		Second-grade cream.	
	Number.	Percentage.	Number.	Percentage.
Desirable.....	216,000,000	77.7	283,000,000	79.7
Undesirable.....	61,700,000	22.2	71,900,000	20.2

While the percentage of the desirable and undesirable type of microorganisms in the two grades of cream differ slightly

from those of the previous year's work, the same conclusions can be drawn. The results indicate either that the proposed method of grading does not determine the true quality of the cream, or that the microbial flora of cream has no influence on the quality. In order to determine which of these conclusions was correct the data obtained from these 135 cream samples were resummarized by classifying the samples into first- and second-grade cream according to the following methods: (1) on a 0.55 percent acidity basis; (2) on a 0.6 percent acidity basis, and (3) by flavor and odor. The results obtained by using the increased basis—that is 0.55 percent and 0.6 percent—are found summarized in tables 5, 6, 7 and 8, respectively, and are self-explanatory. A complete record of the forty-four samples analyzed the previous year was not available for reclassifying.

TABLE 5.

Summary of the different types of microorganisms observed in 135 samples of cream when graded into first- and second-grade cream by 0.55 percent acid.

TYPE.	Number per cubic centimeter.	
	First-grade cream.	Second-grade cream.
Lactic acid type.....	270,000,000	243,000,000
Neutral type.....	113,000,000	47,000,000
Liquefying type.....	2,100,000	2,700,000
Colon group.....	500,000	500,000
Yeasts.....	700,000	400,000

TABLE 6.

Classification of the groups of microorganisms found in first- and second-grade cream when 135 samples were graded on a 0.55 percent acidity basis.

TYPE.	First-grade cream.		Second-grade cream.	
	Number.	Percentage.	Number.	Percentage.
Desirable.....	270,000,000	69.8	243,000,000	82.7
Undesirable.....	116,300,000	30.1	50,600,000	17.2

TABLE 7.

Summary of the different types of microorganisms observed in 135 samples of cream when graded as first- and second-grade cream by 0.6 percent acid.

TYPE.	First-grade cream.	Second-grade cream.
	Number.	Number.
Lactic acid type.....	247,000,000	289,000,000
Neutral type.....	110,000,000	48,000,000
Liquefying type.....	3,300,000	2,700,000
Colon group.....	500,000	600,000
Yeasts.....	600,000	500,000

TABLE. 8.

Classification of the different groups of microorganisms found in the first-grade cream when 135 samples were graded on a 0.6 percent acidity basis.

TYPE.	First-grade cream.		Second-grade cream.	
	Number.	Percentage.	Number.	Percentage.
Desirable.....	247,000,000	68.4	289,000,000	84.8
Undesirable.....	114,400,000	31.5	51,800,000	15.1

Tables 9 and 10 contain the results obtained by grading according to flavor and odor. The data in this case reveal the fact that there exists a difference between the desirable and undesirable groups of organisms in the two grades of cream, in favor of the first-grade cream. This substantiates a working hypothesis that if the poor quality of cream results from the action of microorganisms a difference should be noted in the microbial content of a good and an inferior cream. It therefore follows that cream graded on an acidity basis is an incorrect means of grading in so far as quality is concerned.

TABLE 9.

Summary of the different types of microorganisms observed in 135 samples of cream when graded as first- and second-grade cream by flavor and odor.

TYPE.	Number per cubic centimeter.	
	First-grade cream.	Second-grade cream.
Lactic-acid type.....	299,000,000	243,000,000
Neutral type.....	43,000,000	98,000,000
Liquefying type.....	2,700,000	3,200,000
Colon group.....	600,000	500,000
Yeasts.....	600,000	400,000

TABLE 10.

Classification of the different groups of microorganisms found in first- and second-grade cream when 135 samples were graded by flavor and odor.

TYPE.	First-grade cream.		Second-grade cream.	
	Number.	Percentage.	Number.	Percentage.
Desirable.....	299,000,000	86.4	243,000,000	70.4
Undesirable.....	46,900,000	13.5	102,100,000	29.5

A summary showing the percentages of desirable and undesirable microorganisms found in first- and second-grade cream by the different methods of grading is found in table 11. Table 12 shows the number of the 135 samples examined, classified as first- or second-grade cream by the several methods

of grading. It is interesting to note that the percentage of first-grade cream increased with each increased acidity basis, but the percentage of desirable organisms decreased, while the undesirable forms increased. In the second-grade samples the converse was true.

TABLE 11.

Summary showing the average percentage of desirable and undesirable microorganisms found in the 135 samples of cream examined by the different methods of grading.

METHOD OF GRADING.	First-grade cream.		Second-grade cream.	
	Desirable.	Undesirable.	Desirable.	Undesirable.
On 0.5 percent acidity basis	77.7	22.2	79.7	20.2
On 0.55 percent acidity basis	69.8	30.1	82.7	17.2
On 0.6 percent acidity basis	63.4	31.5	84.8	15.1
On flavor or odor	86.4	13.5	70.4	29.5

TABLE 12.

Table showing how the 135 samples were classified by the different methods of grading.

METHOD OF GRADING.	First-grade cream.		Second-grade cream.	
	Number of samples.	Percentage.	Number of samples.	Percentage.
On 0.5 percent acidity basis	18	13.3	117	86.6
On 0.55 percent acidity basis	35	25.9	100	74.07
On 0.6 percent acidity basis	46	34.0	89	65.9
Flavor and odor	75	55.5	60	44.4

TABLE 13.

A summary showing a comparison of the different methods of cream grading as related to first-grade cream.

METHOD OF GRADING.	Total first-grade samples.	Number of first-grade cream samples.	Number of these samples classed as first-grade by flavor and odor.	Samples classed as second-grade cream, but considered first by flavor and odor.	
				Number.	Percentage.
On 0.5 percent acidity basis	135	18	18	57	76.0
On 0.55 percent acidity basis	135	35	27	48	64.0
On 0.6 percent acidity basis	135	46	29	46	61.3

In Table 13 it will be observed that of the total number of samples considered as first-grade cream by flavor and odor, 76 percent, 64 percent and 61.3 percent were called second-grade when graded on a 0.5 percent, 0.55 percent and 0.6 percent acidity basis, respectively. This demonstrates that grading cream on an acid basis is advantageous to the creamery men, but not to the producer. Its chief commendable feature is that

it stimulates the dairyman to produce, handle and care for his product in a more sanitary manner. This in itself is of great value and importance, but if a more perfect system of cream grading were adopted the same would apply equally as well, and the producer would receive a more just recompense for his endeavors, due to the larger percentage of first-grade cream. The establishment of a standard for grading on a flavor and odor basis is a problem for the dairy official, not the bacteriologist.

SUMMARY.

1. The quality of cream is not correctly determined when graded on an acid basis alone.
2. There is a direct relationship existing between the microbial flora and the quality of cream.
3. The quality of cream can be accurately determined by flavor and odor.

DEPARTMENT OF BACTERIOLOGY, KANSAS AGRICULTURAL EXPERIMENT STATION.